Pump Station Standardization Opportunities Summary of Observations

TO: Thomas V. Sgroi, P.E., Director of Engineering (GNHWPCA)

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DATE: Issued on December 7, 2007

Background

During our November 6, 2007 meeting, it was suggested that Tighe & Bond visit the Authority's small pump stations, together with a few medium pump stations, to further assess standardization opportunities related to pump station configuration. On Wednesday, November 14, 2007, we visited 21 pump stations with Authority and OMI staff. Our observations are summarized as follows.

Current Pump Station Configurations

As discussed in our October 5, 2007 Memorandum, the Authority's pump stations consist of the following configurations:

- Conventional wetwell/drywell with building
- Submersible
- Below grade wetwell/drywell "can"

Conventional Wetwell/Drywell: Of the Authority's 30 pump stations, ten are conventional wetwell/drywell configurations. These consist of the : 1.) East Street; 2.) Boulevard; 3.) Whitneyville; 4.) Morris Cover; 5.) State & Union; 6.) State Street; 7.) Fairview Road; 8.) Welton Street; 9.) Arch Street; and 10.) Mill Rock Pump Stations. Given that most of the above facilities are medium and large pump stations, coupled with their access and maintainability strengths, it is unlikely that future upgrades would involve alternative pump station configurations. Instead, the Authority is more likely to consider replacement pumps, including closed-coupled, extended-shaft and dry-pit submersibles. As such, the conventional wetwell/drywell facilities have been excluded from this evaluation.

Submersible: The Authority has 14 submersible pump stations. These consist of the: 1.) Quinnipiac; 2.) Barnes Avenue; 3.) Long Wharf; 4.) Cosey Beach; 5.) Old Grand Avenue; 6.) Minor Road; 7.) Meadow Street; 8.) Fort Hale; 9.) Market Street; 10.) Stone Street; 11.) West Rock; 12.) New Grand Avenue; 13.) Upper Thompson Street; and 14.) Main Street Pump Stations. The Quinnipiac, Barnes and Long Wharf Pump Stations were recently upgraded and thus will not be included in the context of future pump station standardization discussions. Most of the remaining pump stations are older, and the 11 remaining submersible pump stations were evaluated for standardization opportunities.

Below Grade "Can": The Authority's six remaining pump stations are below grade wetwell/drywell "cans". These consist of the: 1.) Mitchell Drive; 2.) Lovell Street; 3.) Putnam Avenue; 4.) Woodbridge; and 5.) Old Chauncey Road Pump Stations. These pump stations are difficult to access and maintain and were included as part of this effort.

Table 1 (attached) includes updated pump station data, provided by the Authority and supplemented during the site visits. The pump stations have been sorted by design flow.

Pump Station Standardization Opportunities

In the context of the proposed replacement of the Old Chauncey Road Pump Station and the Authority's other pump stations, 17 of the Authority's pump stations, including 11 submersibles and five "cans" were included in this supplemental evaluation.

The Authority has four submersible pump stations (Cosey Beach, Fort Hale, Minor Road and Meadow Street) configured with the wetwell directly beneath the building. In each of these pump stations, the wetwell hatch is located in the same area that houses electrical and control equipment. Replacement alternatives would likely involve the construction of a new wetwell outside the building to comply with code requirements regarding separation of electrical equipment from potential explosive atmospheres. In the case of the Cosey Beach and Minor Road Pump Stations, wetwell depths exceed suction lift pump capabilities, and thus submersible is the most feasible configuration. For the Fort Hale and Meadow Street Pump Stations, wetwell depths are shallower and, in conjunction with a new exterior wetwell, suction lift pumps could be installed in the existing building or submersible pumps could be installed in the new wetwell.

Six of the Authority's submersible pump stations are located either directly in streets or in sidewalks. These include the Main Street, Market Street, New Grand Avenue, Old Grand Avenue, Stone Street and West Rock Pump Stations. Given their relatively shallow wetwells, these pump stations could be reconstructed to accommodate the suction lift configuration. However, each would require difficult land acquisitions. Given their locations, security at these pump stations is less than ideal and an additional at-grade structure may be subject to vandalism. The Old Grand Avenue and New Grand Avenue Pump Stations will require land acquisitions since they are located in the middle of streets, these and the four other sidewalk pump stations are most conducive to a submersible configuration. Each of these six pump stations are most suited to the submersible configuration.

The continued use of the submersible configuration at the Authority's two remaining existing submersible pump stations (Upper Thompson Street and Main Street) will likely continue in the future. Both of these sites have good access and maintenance features.

Of the Authority's six existing "can" pump stations, the Mitchell Drive, Lovell Street, Putnam Avenue and Old Chauncey Road Pump Stations could be similarly converted to either suction lift or submersible configurations. These alternatives would likely be similar to those presented in the October 5, 2007 Memorandum for the old Chauncey Road Pump Station. The Humphrey Street Pump Station is located in a sidewalk, and may best be replaced with a submersible pump station, for reasons similar to the other sidewalk pump stations. Given high head conditions in excess of suction lift pump capabilities, the Woodbridge Pump Station lends itself best to the submersible configuration.

Conclusions

Of the Authority's 17 pump stations being considered for a standardized pump station configuration, only four (all "cans") are ideally suited for the suction lift configuration. Eight other pump stations could accommodate the suction lift configuration, but they would all require land acquisitions or significant retrofit work. In contrast, all of the 17 existing pump stations could be configured as submersible pump stations, especially since 11 are already configured as submersible. In addition, the Barnes, Quinnipiac and Long Wharf Pump Stations were recently upgraded to the submersible configuration.

In the context of the proposed replacement of the Old Chauncey Road Pump Station and the Authority's other similarly sized pump stations, the submersible configuration appears to the most appropriate alternative. With regard to the incorporation of pump station buildings, each pump station is unique, and the use of a building should be based on available land, security concerns, aesthetics and other criteria discussed in the October 5, 2007 Memorandum.

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Engineering Evaluation
Old Chauncey Road Pump Station

TO: Thomas V. Sgroi, P.E., Director of Engineering (GNHWPCA)

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Gary Zrelak, Director of Operations (GNHWPCA)
Charlie Biggs, Operations/Engineering Coordinator (GNHWPCA)

DATE: Issued on October 5, 2007

Background

The Old Chauncey Road Pumping Station (OCRPS) serves a 73-home residential neighborhood west of Hill Street in Hamden, Connecticut. The drainage area (130 acres ±) tributary to the OCRPS is depicted in Figure A-1 (Appendix A). The station was constructed in the early 1970s, and the majority of the original equipment is still in use and is at the end of its useful life. In addition, the Greater New Haven Water Pollution Control Authority (GNHWPCA) is concerned about servicing the existing pumping units due to confined space access limitations.

Project Goals

To address the above concerns and provide the GNHWPCA with an improved pumping station of extended service life and maintainability, replacement of the existing station is needed. To facilitate this effort, the GNHWPCA requested that Tighe & Bond perform two tasks:

- Task 1: Inventory/Classification of Pump Stations – In the context of the recommendations at the Old Chauncey Road Pump Station, the GNHWCPA's thirty existing pumping stations were inventoried and classified. This inventory resulted in distinct categories and facilitated the consideration of opportunities to standardize pumping station systems in the future.

- Task 2: Engineering Evaluation – An engineering evaluation for the OCRPS consisting of the following tasks was performed: (1) meetings; (2) data collection; (3) summary of existing systems; (4) design criteria; (5) upgrade alternatives; (6) recommended plan; and (7) technical memorandum.

Meetings and Site Visits

Several meetings were held as part of the above Tasks. The intent of these meetings, as summarized below, was to develop the pump station inventory, gain an understanding of the preferences of the GNHWPCA staff and to develop replacement recommendations for the OCRPS:

- On May 25, 2007, Tighe & Bond personnel visited the OCRPS with GNHWPCA staff to perform an initial site visit.
- A project kick-off meeting was held at the GNHWPCA office on June 26, 2007 to discuss the project components.
- On July 31, 2007, a pumping station "standardization" workshop was conducted. A copy of the presentation slides from this meeting are included in Appendix D.
- Wetwell drawdown tests were performed by Tighe & Bond staff at the OCRPS on August 8, 2007.

References

Several resources were referenced as part of this evaluation, summarized as follows:

- Plan/profile design drawings (Bowe-Walsh & Associates, Inc. Consulting Engineers) for the sewers tributary to the Old Chauncey Road Pump Station, as constructed in 1970/71 by C.W. Blakeslee & Sons, Inc.
- Technical Report 16 (TR-16), "Guides for the Design of Wastewater Treatment Works", New England Interstate Water Pollution Control Commission, 1998 Edition.
- Pumping Station Design, Second Edition, by Robert L. Sanks, Editor-in-chief, 1998.

Inventory/Classification of Existing Pumping Stations

With consideration for both the replacement of the OCRPS and other future pumping station upgrades in mind, the GNHWCPA's thirty existing pumping stations were inventoried based on the following:

- Pumping station configuration (i.e. wet pit – dry pit, submersible, below-grade can)
- Type of pumping system (i.e. dry pit submersible, submersible, vertical centrifugal)
- Size/capacity of pumping units (horsepower per unit)
- Standby power provisions (i.e. generator, turbine)
- Superstructure/enclosures (i.e. outdoor control panel, building)
- Depth of construction (finish grade and bottom of wetwell)

Based on the above inventory, each pumping station was then classified according to size as follows:

- Small (< 10 horsepower)
- Medium (10 to 100 horsepower)
- Large (> 100 horsepower)

Table 1 provides a summary of the inventory and subsequent classification of the pumping stations. Photos 1, 2 and 3 illustrate examples of large, medium and small pumping stations, respectively. In addition, Table 2 lists each of the 30 pumping stations by category.

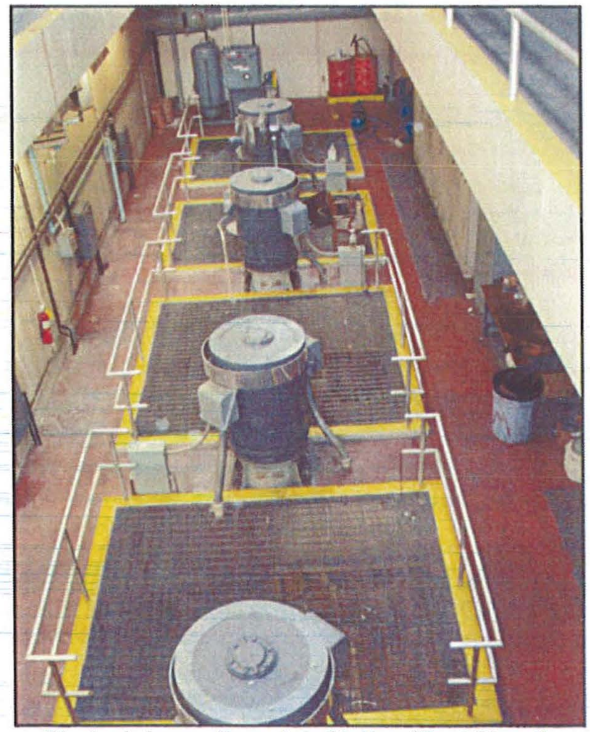

Photo 1: Large Pumping Station (East Street)

Photo 2: Medium Pumping Station (Quinnipiac)

Photo 3: Small Pumping Station (Old Chauncey)

The pumping stations were categorized for several reasons. With regard to size, the criticality of each pumping station became apparent. The larger the pump station flow, the more critical its operation is within the collection system, and the more difficult it would be to operate that facility should its equipment fail. For the larger pumping stations, additional levels of redundancy are needed to allow for reliable backup systems during service work and unanticipated outages. In the context of the OCRPS, the categorization of the pumping stations provided an opportunity to consider standardization for groups of pumping stations with similar features.

TABLE 1
Summary of GNHWPCA Pump Stations

Pumping Station Name	Town	Approximate Size of Pumps (hp)[1,2]	General Category of Pumping Station	Pumping Station Configuration: Wet Pit - Dry Pit: Dry Pit Submersible	Pumping Station Configuration: Wet Pit - Dry Pit: Vertical Centrifugal	Pumping Station Configuration: Submersible	Pumping Station Configuration: Below Grade "Can": Vertical Centrifugal	Other Features: Configured with Building	Other Features: Configured with Generator	Other Features: Outdoor Control Panel	Other Features: Bottom of Wetwell Elevation[2]	Other Features: Pumping Station Finish Grade Elevation[2]	Other Features: Approximate Wetwell Lift (feet)[2,3]
Boulevard	New Haven	400	Large		X			X	X		-20.00	8.50	28.5
East Street	New Haven	300	Large		X			X	X		-19.71	12.00	31.7
Morris Cove	New Haven	150	Large	X				X	X		-18.00	8.50	26.5
State and Union Street	New Haven	75-50-25	Medium		X			X			-17.75	12.42	30.2
Quinnipiac	New Haven	75	Medium			X		X	X		-18.25	8.92	27.2
Barnes Avenue	New Haven	75	Medium			X		X	X		-18.00	10.50	28.5
Welton Street	Hamden	110	Medium	X				X	X		-8.83	10.32	19.2
Woodbridge	Woodbridge	30	Medium				X		X	X			
Fairview Road	East Haven	20	Medium	X				X	X		82.43	100.00	17.6
Arch Street	Hamden	15	Medium		X			X	X				
Cosey Beach	East Haven	18	Medium			X		X	X		-19.33	9.81	29.1
Long Wharf	New Haven	17	Medium			X			X	X	-20.00	5.80	25.8
State Street	Hamden	10	Small		X			X	X				
Whitneyville	Hamden	10	Small		X			X	X				
Minor Road	East Haven	7.5	Small			X		X	X		-22.03	10.14	32.2
Old Grand Avenue	New Haven	10	Small			X				X	-7.37	7.26	14.6
Fort Hale	New Haven	10	Small			X		X			-3.00	11.33	14.3
West Rock	New Haven	5	Small			X				X	-3.20	11.00	14.2
Market Street	New Haven	5	Small			X				X			
Old Chauncey Road	Hamden	7.5	Small				X		X	X			
Lovell Street	Hamden	5	Small				X		X	X			
Putnam Avenue	Hamden	5	Small				X			X			
Humphrey Street	New Haven	5	Small				X			X			
Mitchell Drive	New Haven	5	Small				X			X	-7.75	6.30	14.1
New Grand Avenue	New Haven	3	Small			X				X	0.00	16.00	16.0
Meadow Street	East Haven	7.5	Small			X		X	X		-8.72	10.47	19.2
Main Street	East Haven	3	Small			X				X	-1.15	13.00	14.2
Upper Thomson Street	East Haven	5	Small			X				X	145.00	167.52	22.5
Stone Street	New Haven	5	Small			X				X	1.00	17.24	16.2
Mill Rock	Hamden	5	Small		X			X	X				

[1] Data obtained as part of July 2002 site visits conducted by Tighe & Bond staff for the "Evaluation of Purchase, Operation, and Improvement of Regional Water Pollution Control Assets" for the SSCRWA.
[2] Data provided by the staff of the GNHWPCA.
[3] Wetwell lift can be a limitation of suction lift pumps.

TABLE 2
Categorization of Existing Pumping Stations

Large Pumping Stations (> 100 hp)	Medium Pumping Stations (10 to 100 hp)	Small Pumping Stations (<10 hp)
Boulevard	State and Union Street	State Street
East Street	Quinnipiac	Whitneyville
Morris Cove	Barnes Avenue	Minor Road
	Welton Street	Old Grand Avenue
	Woodbridge	Fort Hale
	Fairview Road	West Rock
	Arch Street	Market Street
	Cosey Beach	Old Chauncey Road
	Long Wharf	Lovell Street
		Putnam Avenue
		Humphrey Street
		Mitchell Drive
		New Grand Avenue
		Meadow Street
		Main Street
		Upper Thomson Street
		Stone Street
		Mill Rock

Summary of Existing Features

The Old Chauncey Road Pumping Station, as shown in Figure 1, is configured as a wet pit/dry pit system, and consists of the following components:

1. **Dry Pit** –The dry pit consists of a below grade steel "can" or drywell, which houses two wastewater pumps and motors, together with 4-inch suction and discharge piping. The invert (elevation 253.5±) of the drywell is approximately 21.5-feet below grade (elevation 275.0±). Entry to the drywell is limited to a 30-inch diameter access tube with a lockable cover, as shown in Photo 4. Routine maintenance inside the drywell is difficult due to confined space entry requirements. The drywell also houses a sump pump, exhaust fan and lights.

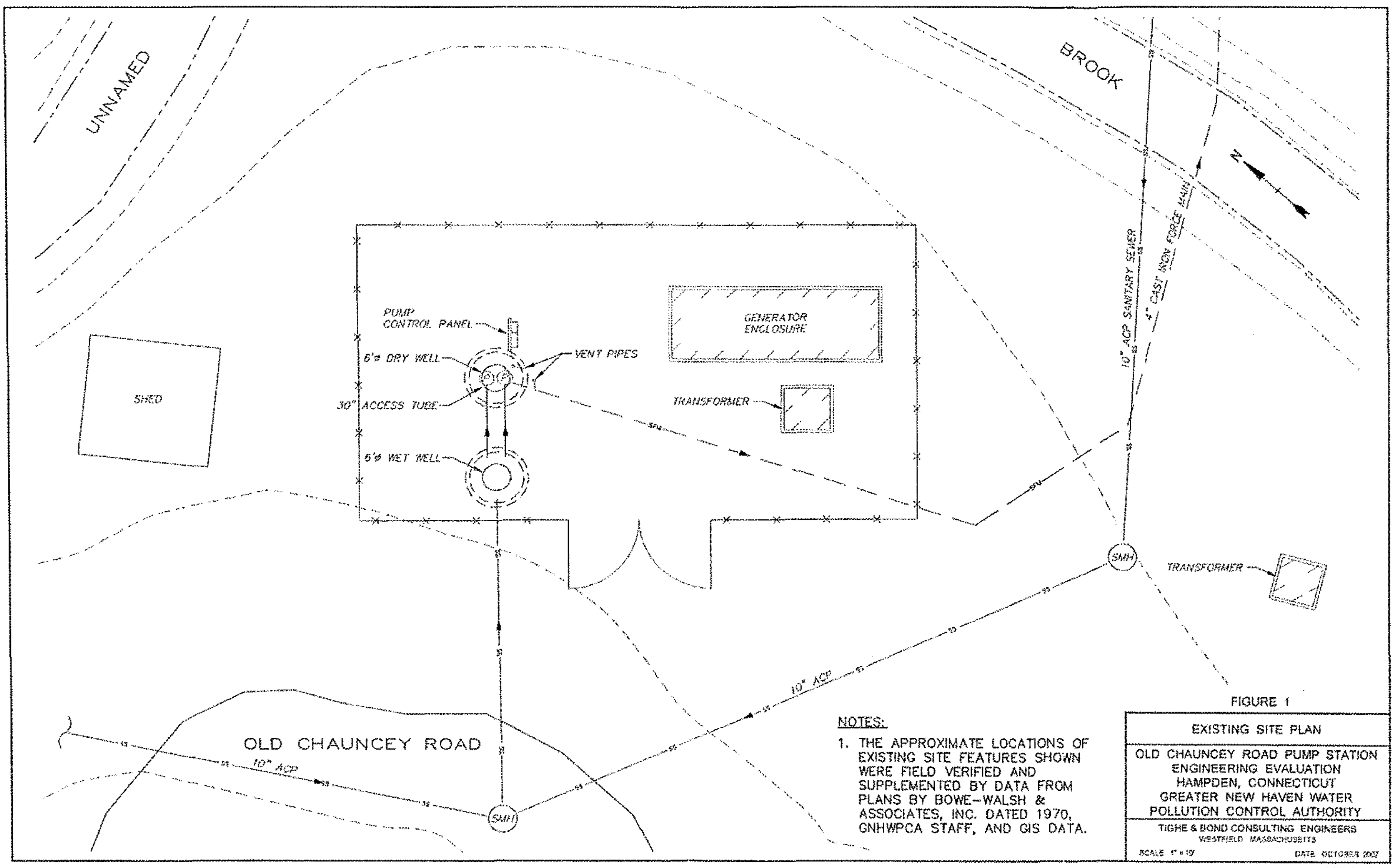
UNNAMED
BROOK
N
PUMP CONTROL PANEL
6'⌀ DRY WELL
VENT PIPES
30" ACCESS TUBE
6'⌀ WET WELL
GENERATOR ENCLOSURE
TRANSFORMER
SHED
10" ACP SANITARY SEWER
4" CAST IRON FORCE MAIN
SMH
TRANSFORMER
10" ACP
OLD CHAUNCEY ROAD
10" ACP
SMH
NOTES:
1. THE APPROXIMATE LOCATIONS OF EXISTING SITE FEATURES SHOWN WERE FIELD VERIFIED AND SUPPLEMENTED BY DATA FROM PLANS BY BOWE-WALSH & ASSOCIATES, INC. DATED 1970, GNHWPCA STAFF, AND GIS DATA.
FIGURE 1
EXISTING SITE PLAN
OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER
POLLUTION CONTROL AUTHORITY
TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD MASSACHUSETTS
SCALE 1" = 10'
DATE OCTOBER 2007

Photo 4: Dry Pit "Can" Access Cover

2. **Wet Pit** – Sewage enters the 6-foot diameter precast concrete wetwell via a 10-inch diameter transite (AC) gravity sewer. The condition of the concrete is difficult to access without a more detailed television inspection of the wetwell interior, but the upper portions of the wetwell appeared to be in reasonable condition given the age of the wetwell. Based on measurements provided by the GNHWPCA staff, the invert elevation of the wetwell is the same as that of the drywell, making it approximately 21.5-feet deep. The vertical distance between the gravity influent pipe invert (elevation 257.7±) and the bottom of the wetwell is 4.2 feet. The total available wetwell storage volume beneath the sewer invert is 888 gallons. Based on the estimated 12-inch change in elevation for each pump on/off cycle, the effective wetwell storage is currently 211 gallons. Each pump draws wastewater from the adjacent wetwell via a dedicated 4-inch suction line. The wetwell is outfitted with a flat top slab and a standard 24-inch diameter manhole frame and cover. Aluminum manhole rungs, visible in Photo 5, are located directly beneath the cover, allowing access to an aluminum grating platform approximately 2-feet above the inlet sewer.

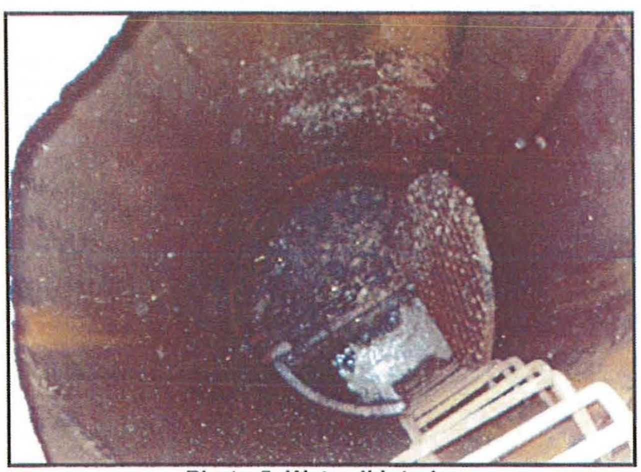

Photo 5: Wetwell Interior

3. **Pumping System** – Two constant speed vertical close-coupled centrifugal non-clog wastewater pumps are in operation at the OCRPS. It is our understanding that these pumping units date back to the 1970s construction project. The pumps have been rehabilitated in the past. According to GNHWPCA staff, a Hamden Sewer Study completed by Malone and MacBroom in 1993, reported that the pumping units are Fairbanks-Morse Model B5442. The pumps are equipped with 4-inch suction and discharge flanges. According to this same report, each pump is rated for 460 gallons per minute (gpm) at a total dynamic head (TDH) of 52-feet, and in parallel, the pumps have a combined rating of 540 gpm at 59-feet TDH. The motor for each pumping unit is 7.5 horsepower (hp), 3-phase, with an operating speed of 1740 revolutions per minute (rpm). The pump nameplates are no longer present, so it is very difficult to field confirm the pump type, model and rated capacity. As noted later in this memorandum, there is some question as to whether or not these particular pumps were installed at the OCRPS as suggested in the 1993 document.

   Most duplex pumping systems are designed such that one pump is adequate to handle peak flows, with the other serving as a standby unit. However, according to GNHWPCA staff, both OCRPS units operate simultaneously at times.

Photo 5: Interior of Drywell Access Way

4. **Pump and Level Controls** – Level control consists of a differential pressure system. A small plastic tube from the wetwell connects to switches inside the drywell. The wetwell invert and gravity sewer invert elevations are 253.7 and 257.7, respectively. Based on our August 8, 2007 site visit observations, the pumps appear to operate at the following settings:
   - Pumps off elevation 255.2
   - Lead pump on elevation 256.2
   - Lag pump on elevation 257.2

5. **Electrical/Instrumentation Systems** –The existing outdoor control panel, shown in Photo 6, houses NEMA 1 motor starters, relays and wiring for the level control system. The OCRPS is not equipped with elapsed time meters (ETM) or a flow meter. Radio telemetry

allows the GNHWPCA to remotely monitor station alarms. The site also contains a transformer adjacent to the generator enclosure.

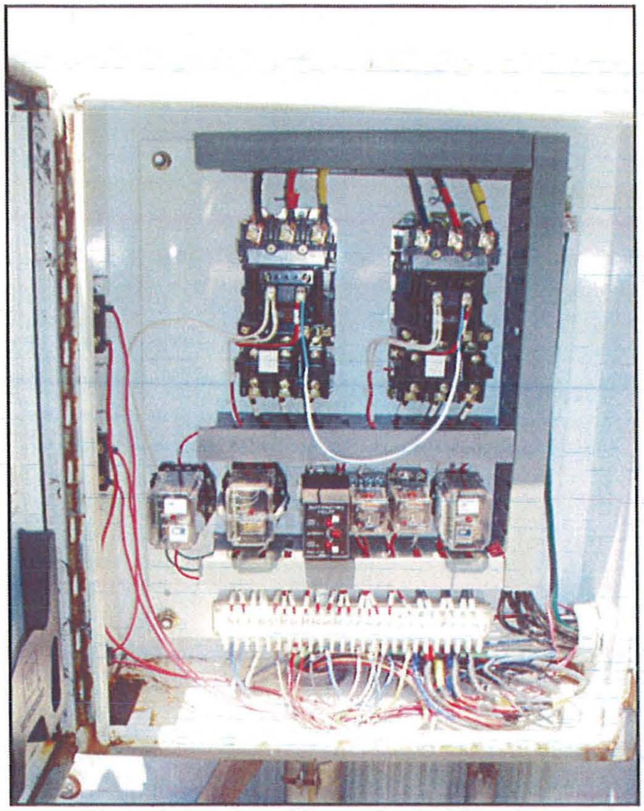

Photo 6: Interior of Pump Control Panel

6. **Emergency Generator** – The OCRPS is equipped with a 30 kilowatt (kW), 240-Volt, 3-phase diesel powered generator and an automatic transfer switch. The air-cooled generator is housed in an uninsulated steel enclosure, at the rear of the fenced enclosure. A unit heater maintains temperature within the enclosure during the winter months. The exterior of the generator enclosure is shown in Photo 7. At one time, diesel fuel for the generator was stored in a 500-gallon underground storage tank adjacent to the generator enclosure, as depicted in Photo 8. However, it is our understanding based on discussions with the GNHWPCA staff that this tank has been abandoned and fuel supply for the existing generator is limited to a small day tank inside the generator enclosure.

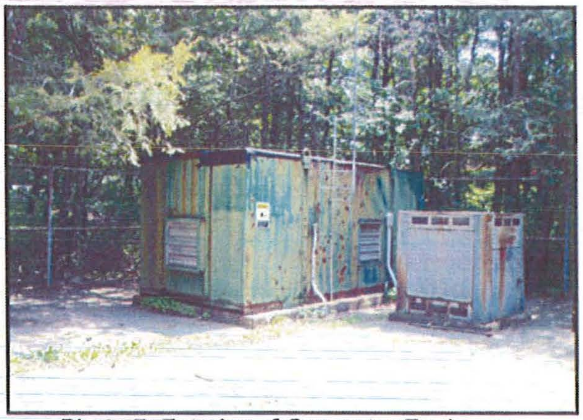
Photo 7: Exterior of Generator Enclosure


Photo 8: Stand-Pipe for Fuel Storage Tank

7. **Discharge Piping** – Sewage is pumped through a 630-foot long, 4-inch diameter cast iron force main from the OCRPS to the northeast across a small brook, where it discharges to a gravity sewer manhole in front of 120/121 Heathridge Road. The pumping station, force main and gravity sewer are depicted in Figure 2.

8. **Site** – As shown in Figure 1, the limits of the Old Chauncey Road Pump Station are secured by a 6-foot high chain link fence. Access to the fenced enclosure is provided via a swing gate. The interior of the enclosure is paved. There is a 30-foot swath of lawn surface between the Old Chauncey Road cul-de-sac and the gate, making truck access to the site difficult in wet weather when the soils are saturated. Large tire ruts are visible in Photo 9 below. Sand and silt deposits are also visible inside the fenced enclosure. During precipitation events, runoff from the west travels directly off Old Chauncey Road to the pumping station interior, resulting in standing water on the site and inflow directly to the wetwell. Thus, drainage at the site can be described as poor.

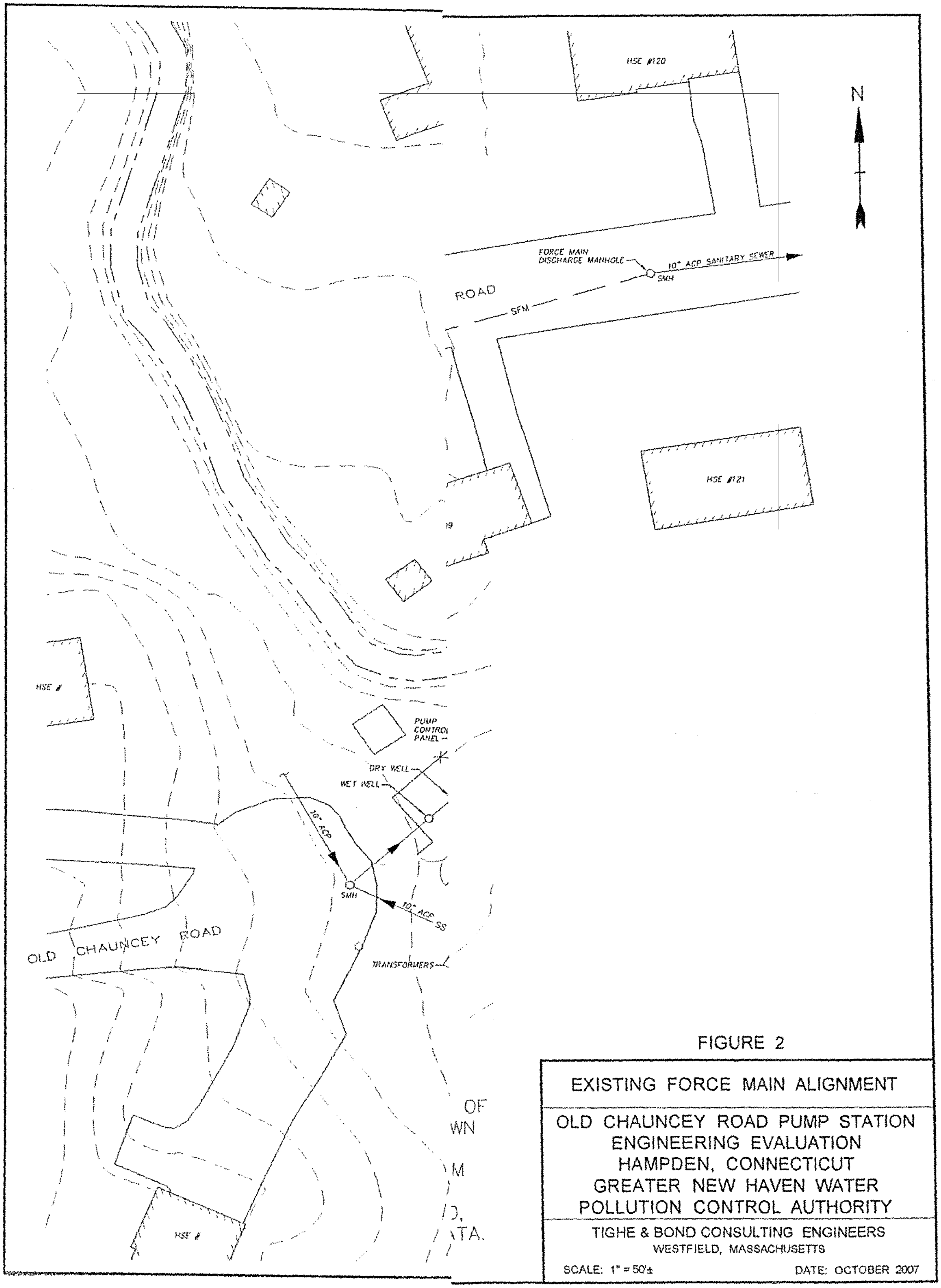

FIGURE 2

EXISTING FORCE MAIN ALIGNMENT

OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER
POLLUTION CONTROL AUTHORITY

TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD, MASSACHUSETTS

SCALE: 1" = 50'± DATE: OCTOBER 2007

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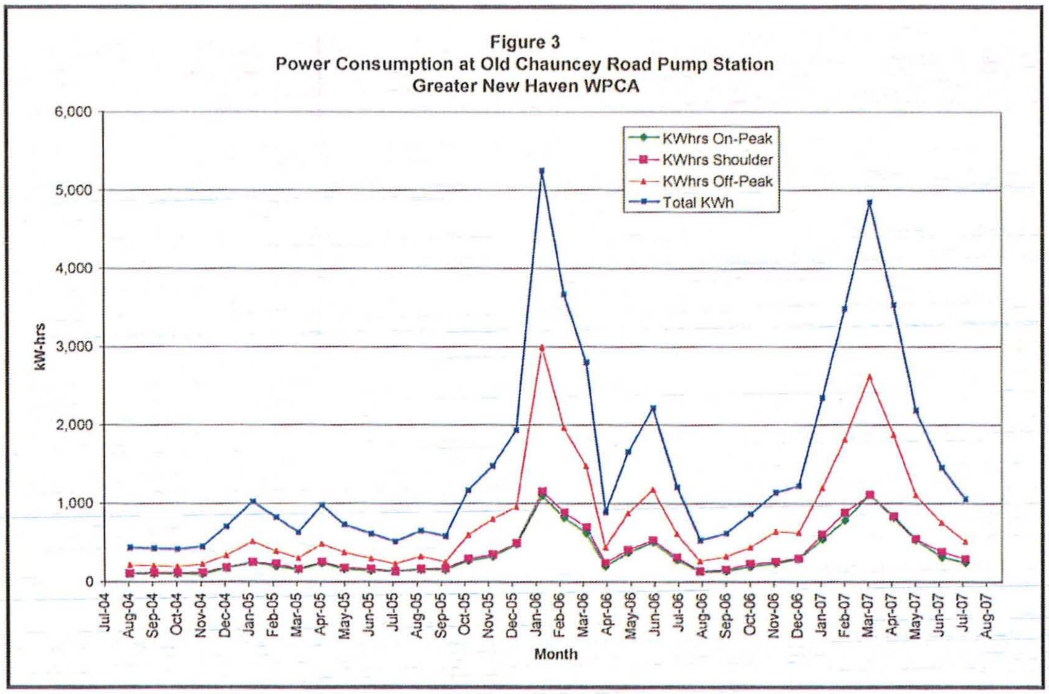
Photo 9: Site Access from Old Chauncey Road

Estimated Current Flow

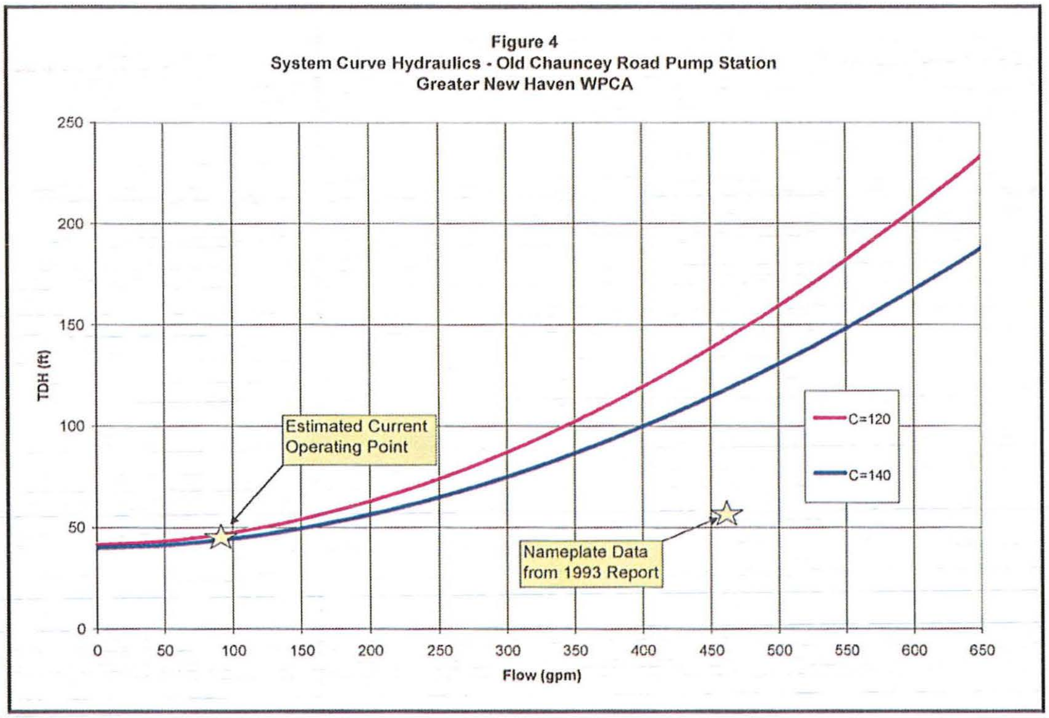
Due to the lack of elapsed time meters (ETM) and flow meter data for the OCRPS, it was necessary to estimate current flows by using power consumption data, conducting wetwell drawdown tests and compare these estimates to theoretical flows from the pumping station service area. Following is a summary of these calculations:

1. **Power Consumption** –The OCRPS has two primary types of devices that consume power, the wastewater pumps and the generator engine block heater. As illustrated in Figure 3, the impact of the generator enclosure heater on power consumption during the winter months in 2006 and 2007 is evident. It does not appear that the engine block heater was in operation during the period from August 2004 to July 2005. During this time period, the average monthly power consumption was 642 kW-hours. Given the estimated brake horsepower for each pump motor (3.8 hp or 2.8 kW) at the estimated operating point (summarized later in this memorandum), the resulting estimated average monthly run time is calculated by converting kW-hours to hours of pump run time per day.



2. **Wetwell Drawdown Tests** – To convert pump run times to flow data, wetwell drawdown tests were performed at the OCRPS on August 8, 2007. These tests suggest that each pump was discharging at rates of approximately 75 gpm and 90 gpm, respectively (average pumping rate of 83 gpm). Compared to the nameplate data summarized in Hamden's 1993 Sewer System Study, the observed pumping rate is significantly lower than the nameplate capacity of 460 gpm.

3. **System Curve** – A system curve was generated to confirm the pumping system hydraulics. Figure 4 shows the anticipated system curves for a 4-inch cast iron force main of varying roughness coefficients, together with the pump nameplate data from the 1993 Study. The results shown in Figure 4 suggest that although pumps rated for 460 gpm may have been installed at the OCRPS, the pumping units are either now operating at a significantly lower flow rate based on the system curve, or the pumps have been replaced with units of lower operating capacity. Given the existing 4-inch diameter force main, and an excessive corresponding operating velocity of 12 fps for a design flow of 460 gpm, we do not believe that the OCRPS was originally rated for 460 gpm.



4. **Pumping Station Drainage Area** – The Old Chauncey Road Pump Station serves a small residential neighborhood in Hamden, as shown in Figure 1. Approximately 73 existing single family homes discharge to the OCRPS. Assuming that each residence houses approximately four people at unit water consumption rate of 75 gallons per day per capita (gpcd), the resulting theoretical average daily flow from residential sources is 21,900 gpd.

5. **Infiltration/Inflow** - In addition, the sewer system tributary to the OCRPS consists of roughly 10.6 inch-diameter miles (idm) of gravity sewers. Based on an assumed average daily infiltration/inflow (I/I) contribution of 500 gpd/idm for 40-year old gravity sewers, the average daily I/I flow contribution is 5,300 gpd.

The resulting total theoretical average daily flow is 27,200 gpd. Using peaking factors of 4.0 and 5.6 for peak day and peak hour flows, respectively, estimated existing system flows are summarized in Table 3. Power consumption data for June 2006, a very wet but warm month, was assumed to be roughly equivalent to the maximum month flow rate, also shown in Table 3.

Table 3
Estimated Pumping System Flow Rates

	Calculated Pump(s) Run Time (hr/d)	Calculated Flow Rate Based on Drawdown Pumping Rate[3] (gpd)	Estimated Flow Rate Based on Drainage Area[4] (gpd)
Average Month	7.64	38,000	27,200
Maximum Month[5]	26.3	131,000	94,000
Estimated Peak Day[1]	30.6	152,000	109,000
Estimated Peak Hour[2]	42.8	213,000	152,000

[1]Peak day to average day ratio of 4.0 used
[2]Peak hour to average monthly ratio of 5.6 used
[3]Based on observed drawdown pumping rate of 83 gpm
[4]Based on 75 gpcd and 4 people per home (73 in total) plus 500 gpd/idm (10.6 idm)
[5]Based on June 2006 data

The calculated average daily flow in Table 3 is relatively close to the estimated average daily flow rate, which provides a good correlation between the run time data and the estimated data. Based on a 4-inch diameter force main, a minimum pumping rate of 77 gpm is desired to maintain a scouring velocity of 2.0 feet per second (fps). This too, suggests that the run time and theoretical estimated data reasonably approximated existing flows. Current wastewater flows are summarized in Table 4.

TABLE 4
Current Wastewater Flow Generation

Current Average Daily Flow (Residential)	21,900 gpd
Est. Average Infiltration/Inflow (200 gpd/in-mile)	5,300 gpd
Total Current Average Daily Flow	27,200 gpd
Peaking Factor Based on TR16 Guidelines	5.6 (Ratio to Total Average Daily Flow)
Estimated Current Peak Flow Rate	152,000 gpd (106 gpm)

Future Flow Projections

Future flows were estimated based on the results of a projected build-out analysis within the drainage area tributary to the OCRPS, which included residential build-out, along with an allowance for I/I. In total, an additional 15 homes (4,500 gpd) might be developed within the drainage area tributary to the OCRPS, together with an additional 2.2 idm (1,100 gpd) of collector sewers. Projected future wastewater flows are summarized in Table 5.

TABLE 5
Future Wastewater Flow Projection Based on Build-Out Analysis

Total Current Average Daily Flow	27,200 gpd
Future Additional Average Daily Flow (Residential + I/I)	5,600 gpd
Total Future Average Daily Flow	32,800 gpd
Peaking Factor Based on TR16 Guidelines	5.6 (Ratio to Total Average Daily Flow)
Estimated Future Peak Flow Rate	184,000 gpd (128 gpm)

Pumping System Design Criteria

Based on the data presented in Table 5, the peak future theoretical flow rate is 128 gpm. However, based on the power consumption data, a peak flow rate of 148 gpm was calculated. To provide a factor to safety to the anticipated future peak flow rate, a range of 150 gpm (52-feet TDH) to 200 gpm (60-feet TDH) has been chosen as the basis of design for the new pumping system. This corresponds to a scouring velocity of 3.9 to 5.2 fps in the existing 4-inch diameter force main. Based on the projected peak future flow rate, only one pump should be needed except during extreme high flow events, with the second pump serving as a standby unit. In addition, it may be possible to reduce peak flows and subsequent operating costs by reducing I/I within the collection system tributary to the OCRPS.

Pumping Station Configuration Alternatives

A number of alternative pumping station configurations are available to the current "can" configuration at the OCRPS. The most commonly constructed configurations include wet/dry pit, submersible and suction lift (self-primed and vacuum primed). Table 6 summarizes the various pumping station configurations, together with their respective advantages and disadvantages.

Table 6
Comparison of Pumping Station Configurations

Pump Station Configuration	Advantages	Disadvantages
Prefabricated Can Stations	Moderate cost Pumps not in wetwell No depth limit	Personnel access Can longevity Equipment access Pump options include close-coupled and dry pit submersible
Wet/Dry Pit Stations	Access No depth limit Longevity	High cost if new Space requirements Can be built in place or prefabricated Pump options include extended shaft, close-coupled and dry pit submersible
Submersible Stations	Lowest pump cost No depth limit Building not required Small footprint	Access to pumps Pump maintenance Wiring/connections Pump longevity Wetwell can be built in place or prefabricated
Self-Prime/Suction Lift Stations	Ease of maintenance Pumps not in wetwell Moderate cost Interchangeable components	Limited suppliers Limited lift (25'+/-) Efficiency Can be located in prefabricated enclosure or building
Vacuum Prime Stations	Pumps not in wetwell Moderate cost, slightly less than self-prime	Automatic priming system required May be located partially over wetwell Max depth 18' to 25' Usually located in a prefabricated enclosure

While it is possible to construct a robust replacement pumping station with walk-down access to both drywell and wetwell, this configuration would not be cost effective. Similarly, a reconstructed "can" configuration would not eliminate the concerns regarding confined space. Instead, the capacity of the OCRPS lends itself to submersible and suction lift pumping systems. Although both self-primed and vacuum-primed applications are available for the suction lift configuration, vacuum-primed pumping systems have a higher operating cost due to maintenance of the vacuum-priming system, and thus self-priming suction lift pumping systems are preferred. The remainder of this evaluation focuses on these two pumping station configurations. The four following alternatives were developed and discussed at the July 31st meeting:

Alternative 1: Submersible Without Building - Alternative 1 involves the construction of a submersible pumping station, with submersible pumps installed in the existing wetwell. A new outdoor control panel would be installed adjacent to the wetwell, and a valve vault would be constructed opposite the control panel. The discharge piping would be connected to the existing force main. A new outdoor generator would be installed in a weather-proof enclosure, and the drywell, old controls and generator/enclosure would be demolished and the site restored. Figures B-1, B-2 and B-3 (Appendix B) illustrate the schematic pumping station configuration for Alternative 1.

Alternative 2: Submersible With Building - Alternative 2 involves the construction of a submersible pumping station, with submersible pumps installed in the existing wetwell. A building would be constructed adjacent to the wetwell to house the new control panel and generator. The discharge piping would be connected to the existing force main. The drywell, old controls and generator/enclosure would subsequently be demolished and the site restored. Figures B-4, B-5 and B-6 (Appendix B) illustrate the schematic pumping station configuration for Alternative 2.

Alternative 3: Suction Lift Without Building - Alternative 3 involves the construction of a self-priming pumping station, with the suction lift pumps installed in a 6-foot by 6-foot fiberglass enclosure adjacent to the wetwell. A new outdoor control panel would be installed adjacent to the wetwell. The discharge piping would be connected to the existing force main. A new outdoor generator would be installed in a weather-proof enclosure, and the drywell, old controls and generator/enclosure would be demolished and the site restored. Figures B-7, B-8 and B-9 (Appendix B) illustrate the schematic pumping station configuration for Alternative 3.

Alternative 4: Suction Lift With Building - Alternative 4 involves the construction of a self-priming pumping station, with suction lift pumps, new control panel and new generator would be housed in a building adjacent to the wetwell. The discharge piping would be connected to the existing force main, and the drywell, old controls and generator/enclosure subsequently demolished prior to the site being restored. Figures B-9, B-10, B-11 and B-12 (Appendix B) illustrate the schematic pumping station configuration for Alternative 4.

Photos 10 through 13 illustrate examples of the pumping station configurations described for Alternatives 1 through 4, respectively.


Photo 10: Alternative 1 Configuration


Photo 11: Alternative 2 Configuration


Photo 12: Alternative 3 Configuration

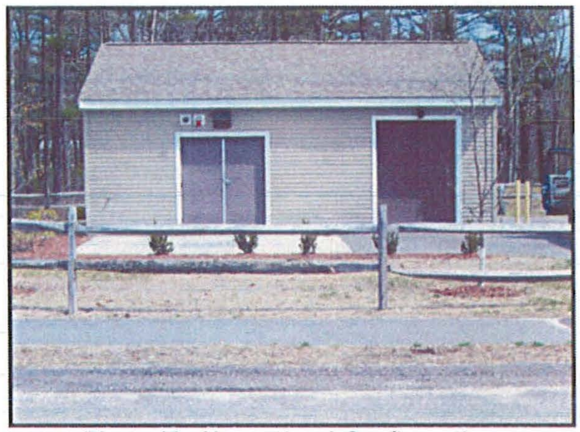


Photo 13: Alternative 4 Configuration

For Alternatives 2 and 4, which include above ground buildings, several building types are readily available. These include precast concrete, masonry block, and stick-built buildings. In addition, various building exteriors are available including block, brick and vinyl. However, for the purpose of reviewing the various alternatives, costs for single wythe masonry block buildings with vinyl exteriors have been used.

Due to the drainage problems at the site, each Alternative involves site improvements to prevent street runoff from entering the site. Further all of the alternatives include SCADA, bypass pump, flow metering and other GNHWPCA "standard" pumping station provisions/preferences.

Alternatives Analysis

Several parameters were included in the alternatives analysis, including excavation depth, space limitations and constructability and maintainability (ease of access, serviceability). Life cycle costs (capital, O&M, power, longevity) were developed for each of the four Alternatives, together with present worth costs. The costs presented are planning level estimates based on past projects and experience, and will need to be refined when the design is completed. Tables C-1, C-2 C-3 and C-4 (Appendix C), which contain the life cycle and present worth cost data for Alternatives 1 through 4, respectively, have been consolidated into Table 7.

Table 7
Summary of Estimated Probable Costs

Alternative No.	Capital Cost	Annualized Cost	Present Worth Cost
1	$528,000	$53,500	$722,000
2	$681,000	$68,000	$915,000
3	$481,000	$56,600	$790,000
4	$733,000	$77,700	$1,060,000

Recommended Improvements

All of the above Alternatives will improve maintainability at the OCRPS. Although Alternatives 2 and 4 provide a building to house the mechanical and electrical equipment, they do so at a significantly higher price. If pumping station configuration is selected based on life cycle costs, and a building is not necessary for aesthetic or other purposes, Alternatives 1 and 3 least expensive configurations. Alternatives 1 and 3 have similar life cycle costs. However, should the GNHWPCA choose to implement Alternative 1, the recommendations for improvements at the Old Chauncey Road Pump Station are summarized as follows:

1. **Wetwell** - The existing 6-foot diameter precast concrete wetwell will be reused to house the new submersible wastewater pumps. The uppermost section of the wetwell will be removed and replaced with a flat top slab to accommodate a flood-tight aluminum access hatch, since the existing manhole cover is not large enough to accommodate the proposed pumping units. During the wetwell drawdown tests, it became evident that the wetwell itself may in fact be a significant I/I contributor, as significant I/I was visible (approximately 5 to 10 gpm) following a heavy rainfall event. Prior to proceeding with the recommended improvements, the GNHWPCA should televise the interior of the wetwell using remote inspection equipment, to more closely inspect the integrity of the wetwell. The cost estimate includes provisions for coating the interior of the existing wetwell.

2. **Wastewater Pumps** - Two new 7.5 hp submersible wastewater pumps and motors, together with a slide rail removal system, will be installed in the existing wetwell. The design point for each pump is estimated to be 200 gpm at 60-feet TDH (one pump running with one spare standby unit). Electrical quick disconnect devices (Photos , similar to those being utilized at the Barnes and Quinnipiac Pumping Stations, will be incorporated into the design.

Photo 14: Interior of Pump Disconnect Assembly

Photo 15: Exterior of Pump Disconnect Assembly

3. **Pump Control Panel** – The pumps will be activated by constant speed across-the-line starters. The pump control panel will incorporate a programmable logic controller (PLC) and SCADA provisions, consistent with the GNHWPCA's existing SCADA system (Modicon).

4. **Pipe Work** – The 4-inch force main (suction and discharge) piping will be constructed within the wetwell to accommodate the two new wastewater pumps, discharge piping to and through the valve vault, together with a dedicated force main isolation valve and by-pass pump connection. Install a magnetic flowmeter to allow for accurate flow metering capabilities at the pump station.

5. **Generator** – The proposed improvements include a standby diesel fueled emergency generator with a belly tank capable of providing electrical service to the entire pumping station during power outages.

6. **Demolition Work** – Installation of the new equipment will require demolition of the existing pumps/motors, portions of the drywell, as well as portions of the existing electrical wires and controls. To maintain pump station operation during demolition and installation of the new pumping units, a phased upgrade should be considered along with bypass pumping requirements.

7. **Site Considerations** – The recommended improvements include site improvements to prevent street runoff from entering the site. Odor control consisting of venting through carbon canisters (55 gallon drums), shown in Photo 16, will be considered in the final design based on input from the GNHWPCA.

Photo 16: Odor Control System

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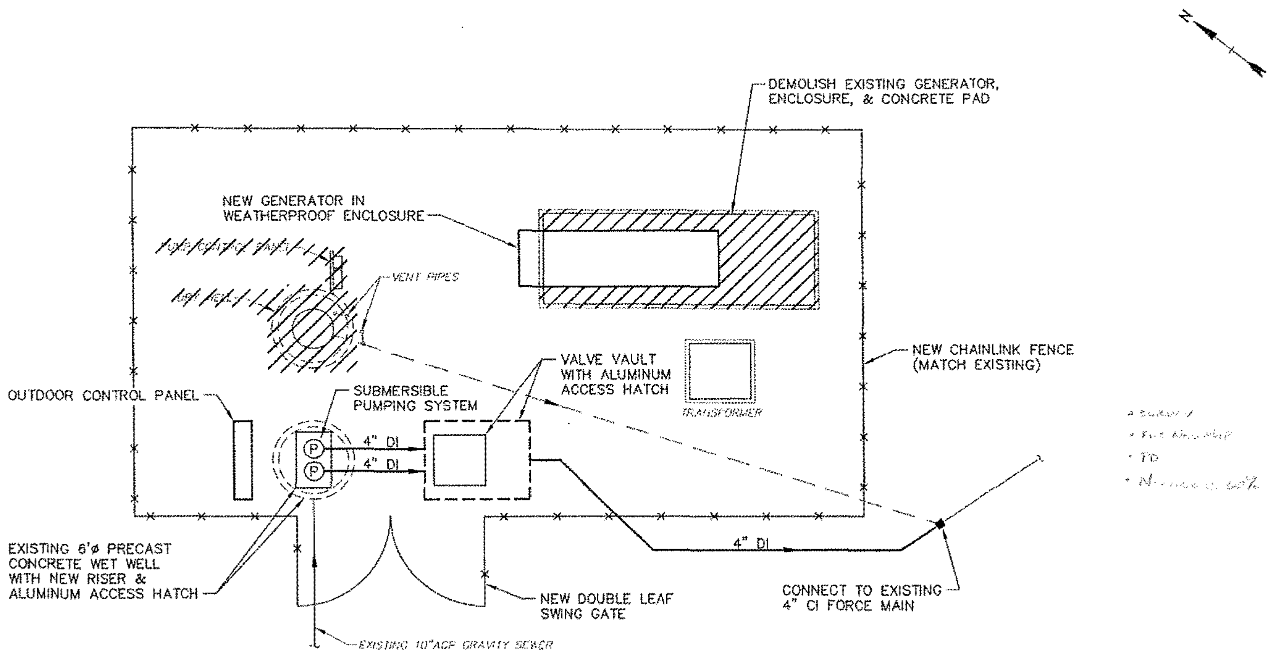


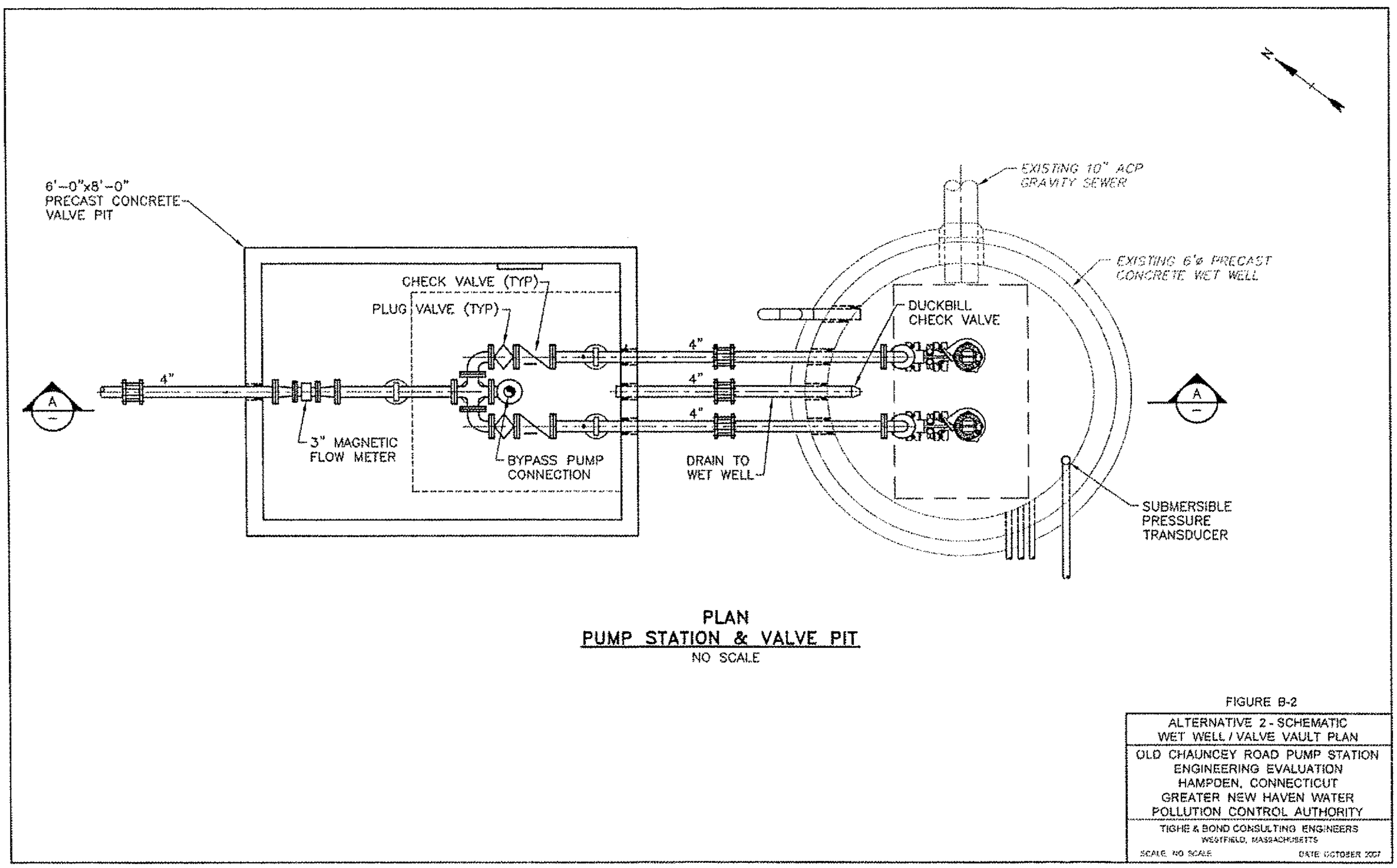
FIGURE B-1

ALTERNATIVE 1 - SCHEMATIC SITE PLAN

OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER
POLLUTION CONTROL AUTHORITY

TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD, MASSACHUSETTS

SCALE: 1"=5'　　DATE: OCTOBER 2007



N
6'-0"x8'-0"
PRECAST CONCRETE
VALVE PIT
EXISTING 10" ACP
GRAVITY SEWER
EXISTING 6'ø PRECAST
CONCRETE WET WELL
CHECK VALVE (TYP)
PLUG VALVE (TYP)
DUCKBILL
CHECK VALVE
4"
4"
4"
4"
A
A
3" MAGNETIC
FLOW METER
BYPASS PUMP
CONNECTION
DRAIN TO
WET WELL
SUBMERSIBLE
PRESSURE
TRANSDUCER
PLAN
PUMP STATION & VALVE PIT
NO SCALE
FIGURE B-2
ALTERNATIVE 2 - SCHEMATIC
WET WELL / VALVE VAULT PLAN
OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER
POLLUTION CONTROL AUTHORITY
TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD, MASSACHUSETTS
SCALE: NO SCALE
DATE: OCTOBER 2007

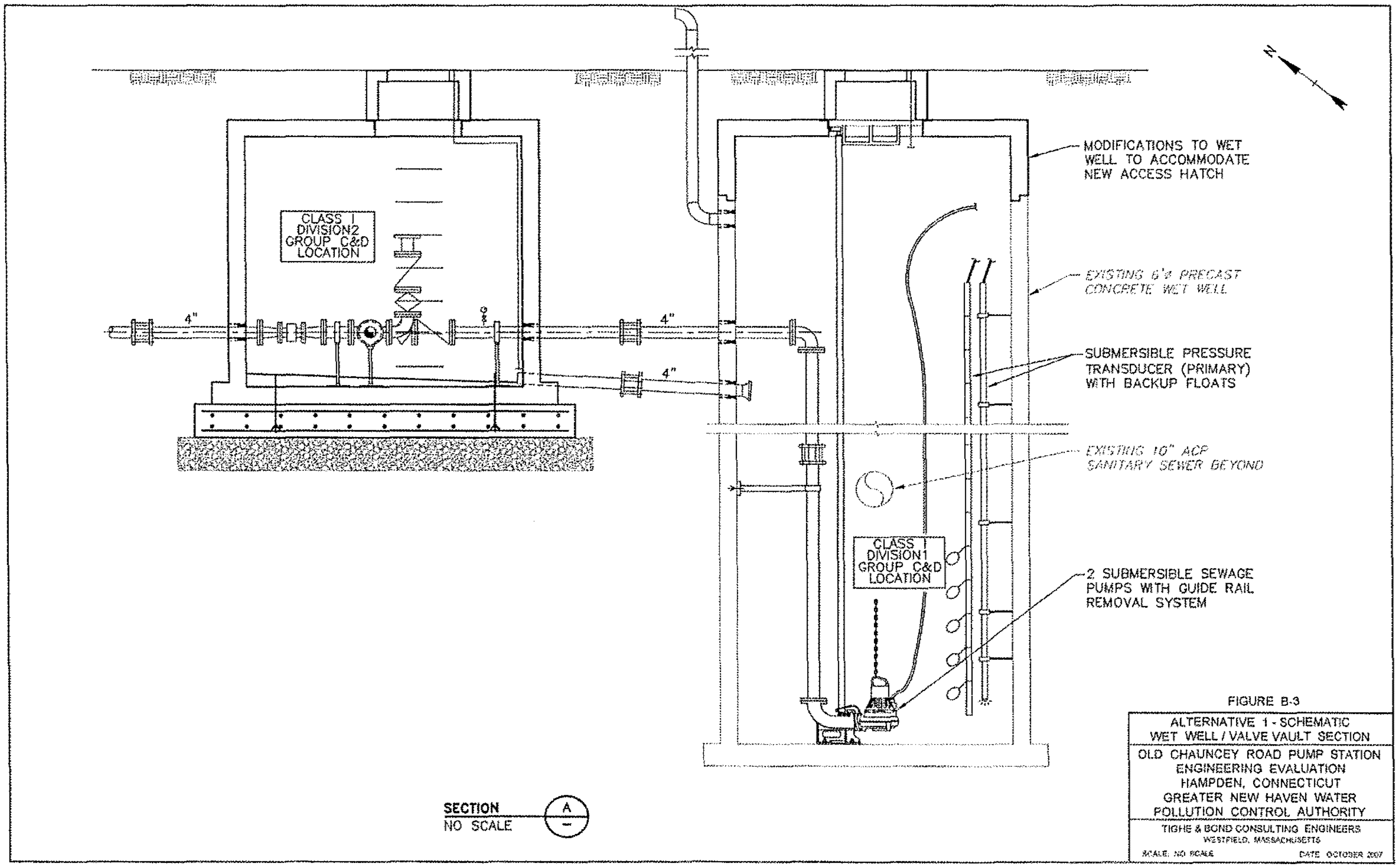


FIGURE B-3

ALTERNATIVE 1 - SCHEMATIC
WET WELL / VALVE VAULT SECTION

OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER
POLLUTION CONTROL AUTHORITY

TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD, MASSACHUSETTS

SCALE: NO SCALE   DATE OCTOBER 2007

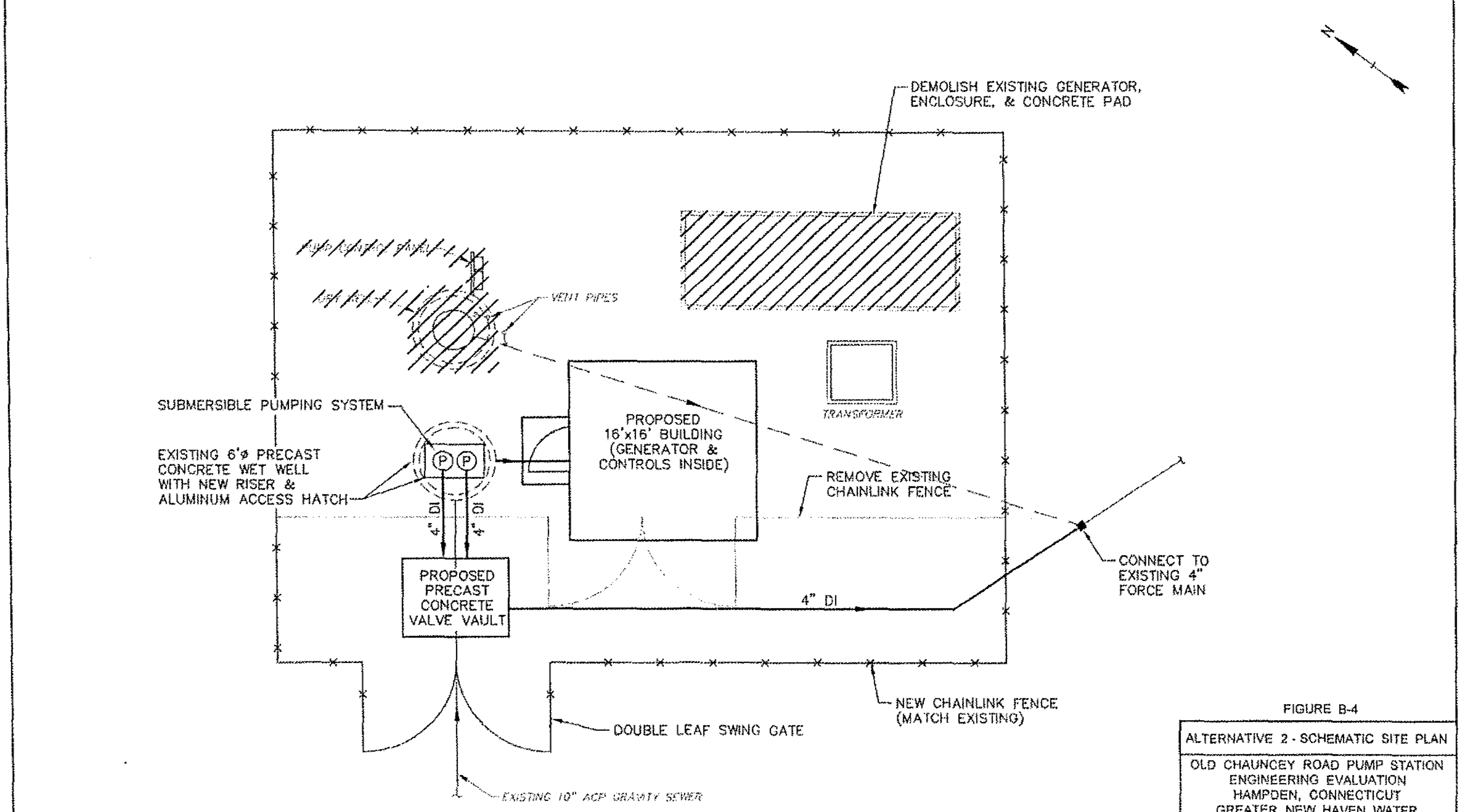


FIGURE B-4

ALTERNATIVE 2 - SCHEMATIC SITE PLAN

OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER
POLLUTION CONTROL AUTHORITY

TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD, MASSACHUSETTS

SCALE: 1" = 8' DATE: OCTOBER 2007

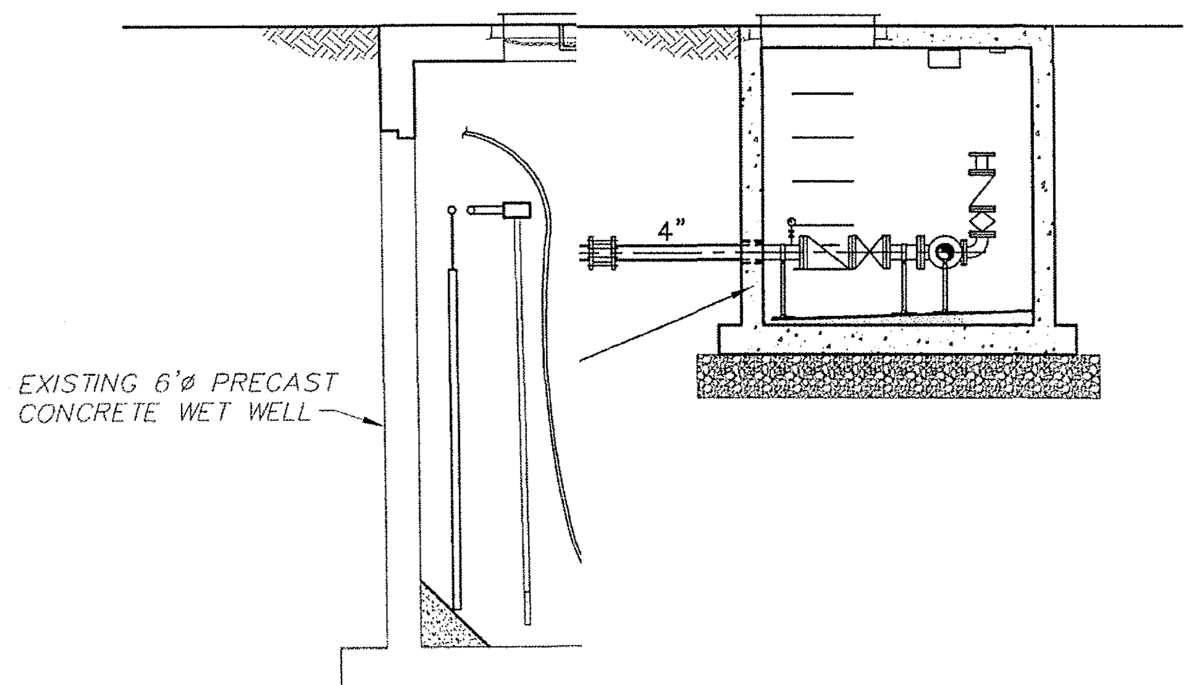


FIGURE B-6

ALTERNATIVE 2 - SCHEMATIC PUMP STATION CROSS SECTION
OLD CHAUNCEY ROAD PUMP STATION ENGINEERING EVALUATION HAMPDEN, CONNECTICUT GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
TIGHE & BOND CONSULTING ENGINEERS WESTFIELD, MASSACHUSETTS
SCALE: NO SCALE DATE: OCTOBER 2007

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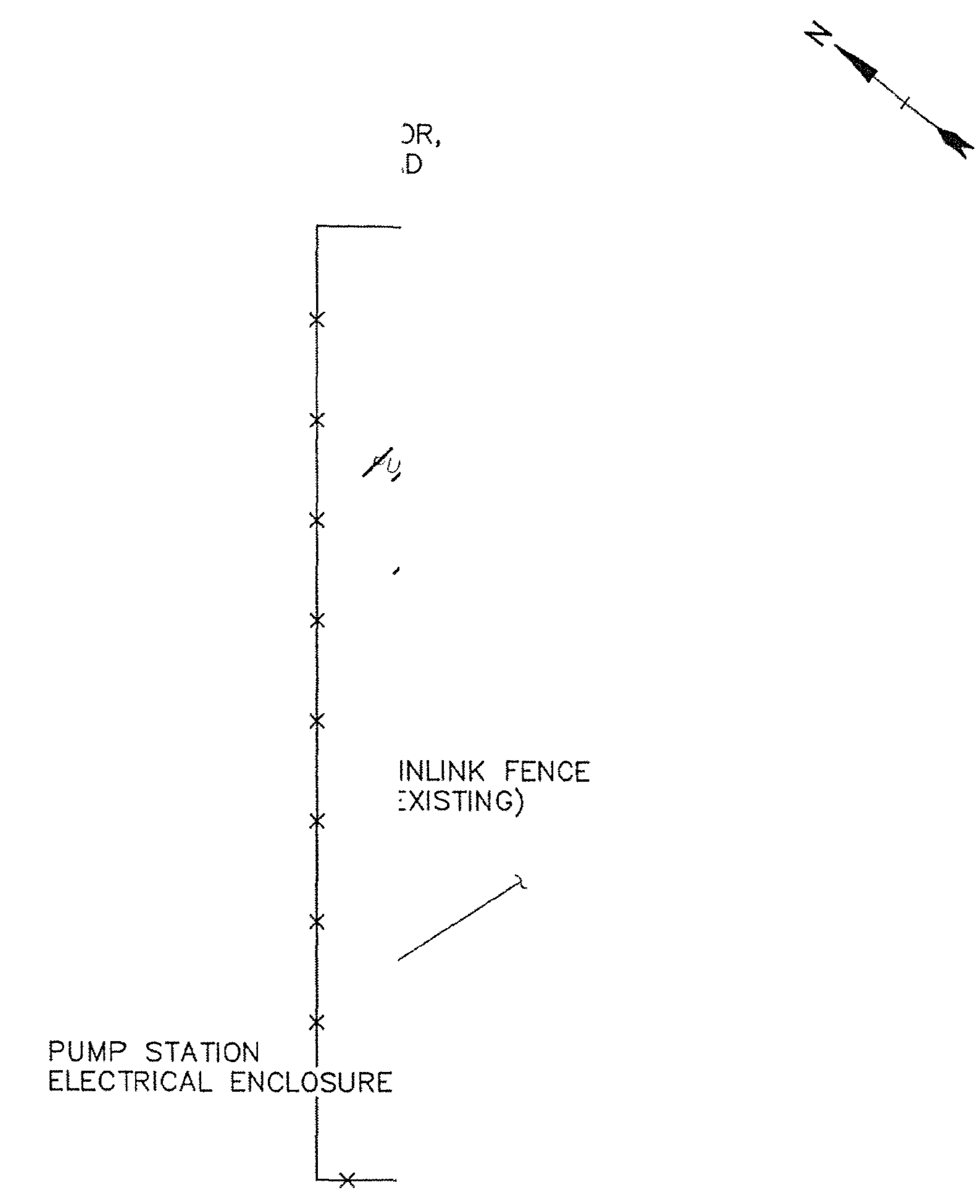

FIGURE B-7

ALTERNATIVE 3 - SCHEMATIC SITE PLAN

OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER
POLLUTION CONTROL AUTHORITY

TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD, MASSACHUSETTS

SCALE: 1" = 8'   DATE: OCTOBER 2007

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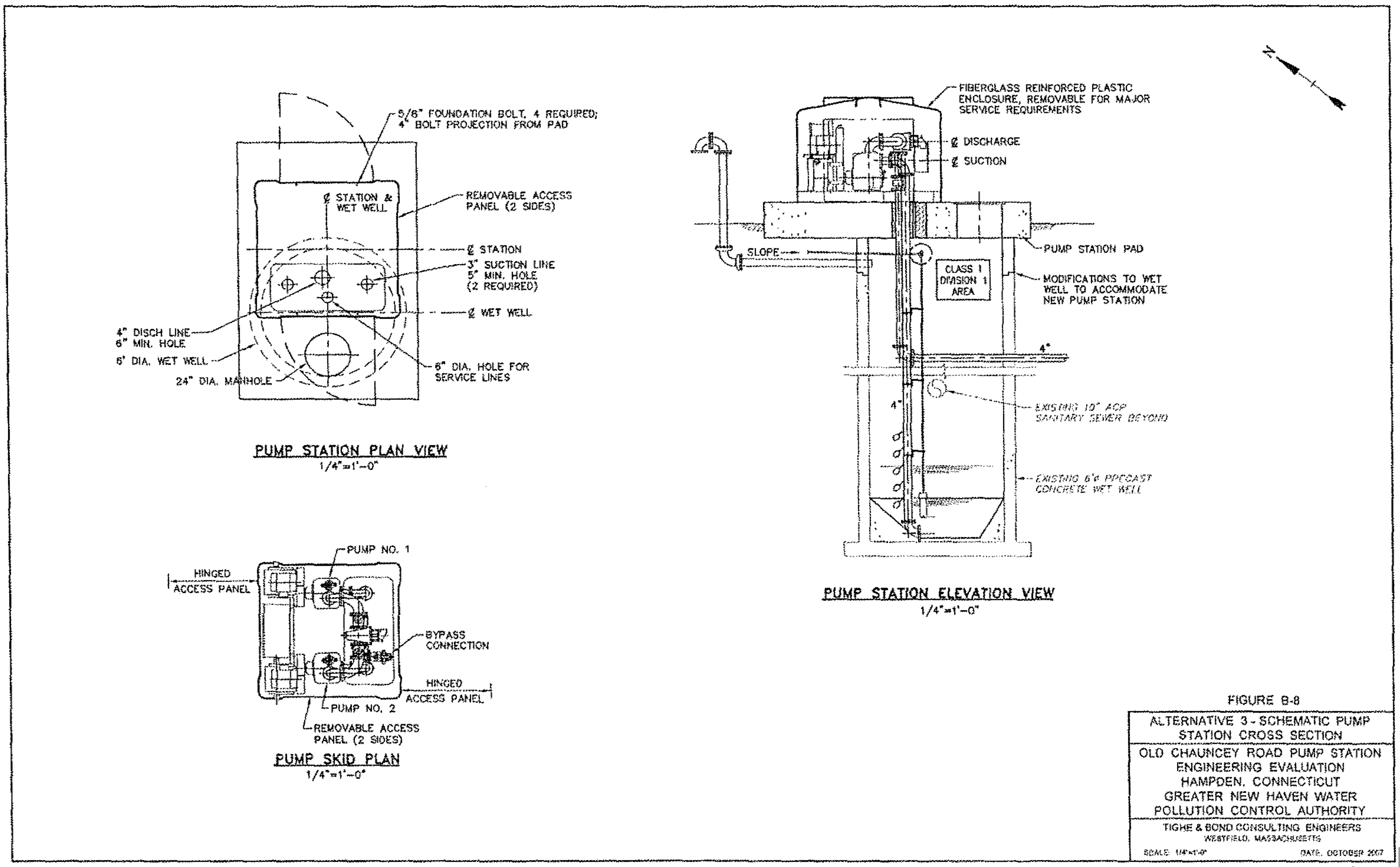
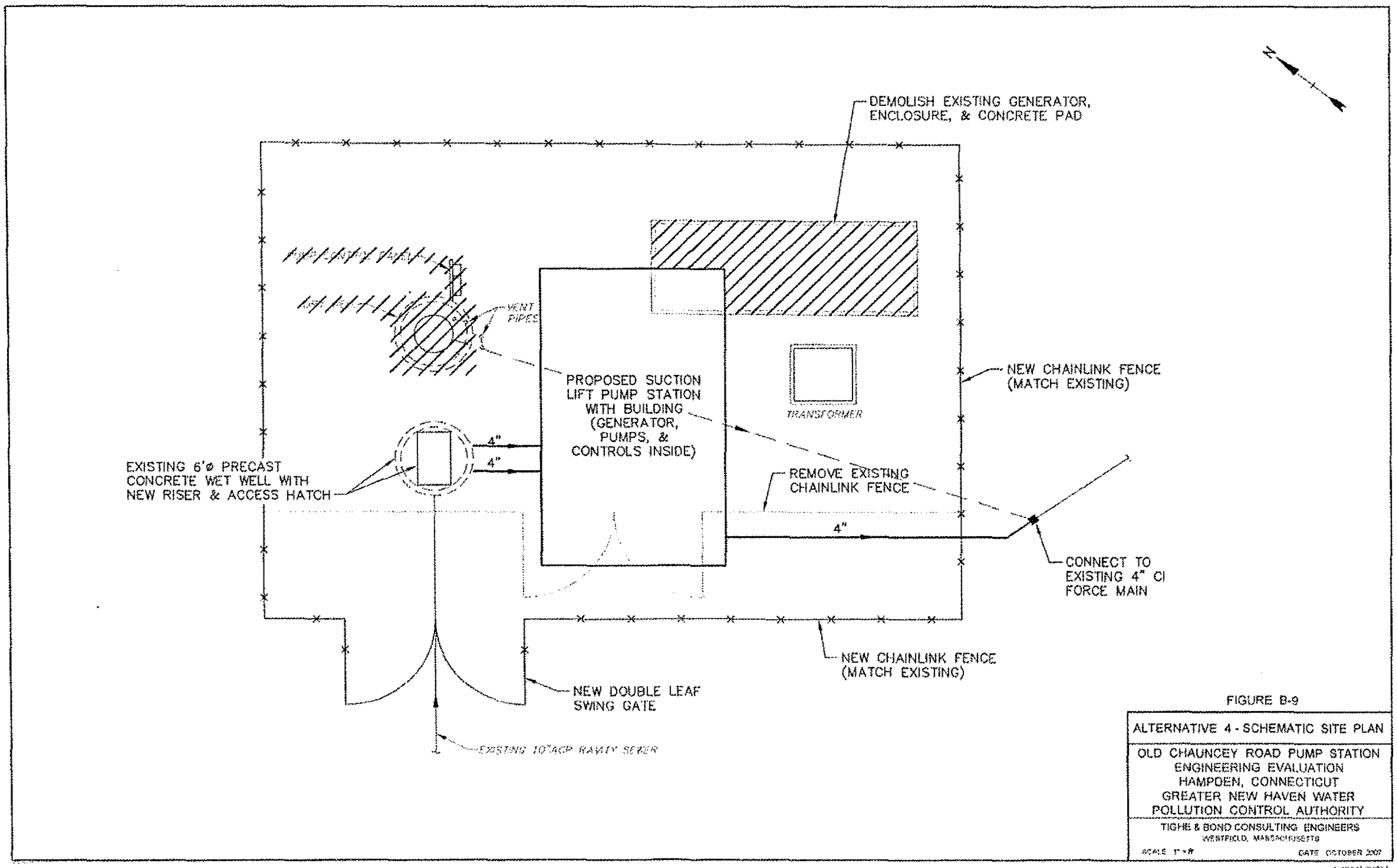

5/8" FOUNDATION BOLT, 4 REQUIRED; 4" BOLT PROJECTION FROM PAD
℄ STATION & WET WELL
REMOVABLE ACCESS PANEL (2 SIDES)
℄ STATION
3" SUCTION LINE 5" MIN. HOLE (2 REQUIRED)
℄ WET WELL
4" DISCH LINE 6" MIN. HOLE
6' DIA. WET WELL
24" DIA. MANHOLE
6" DIA. HOLE FOR SERVICE LINES
PUMP STATION PLAN VIEW
1/4"=1'-0"
PUMP NO. 1
HINGED ACCESS PANEL
BYPASS CONNECTION
HINGED ACCESS PANEL
PUMP NO. 2
REMOVABLE ACCESS PANEL (2 SIDES)
PUMP SKID PLAN
1/4"=1'-0"
FIBERGLASS REINFORCED PLASTIC ENCLOSURE, REMOVABLE FOR MAJOR SERVICE REQUIREMENTS
℄ DISCHARGE
℄ SUCTION
SLOPE
PUMP STATION PAD
CLASS 1 DIVISION 1 AREA
MODIFICATIONS TO WET WELL TO ACCOMMODATE NEW PUMP STATION
4"
4"
EXISTING 10" ACP SANITARY SEWER BEYOND
EXISTING 6'ø PRECAST CONCRETE WET WELL
PUMP STATION ELEVATION VIEW
1/4"=1'-0"
FIGURE B-8
ALTERNATIVE 3 - SCHEMATIC PUMP STATION CROSS SECTION
OLD CHAUNCEY ROAD PUMP STATION ENGINEERING EVALUATION HAMPDEN, CONNECTICUT GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD, MASSACHUSETTS
DATE: OCTOBER 2007


N
DEMOLISH EXISTING GENERATOR, ENCLOSURE, & CONCRETE PAD
VENT PIPES
PROPOSED SUCTION LIFT PUMP STATION WITH BUILDING (GENERATOR, PUMPS, & CONTROLS INSIDE)
TRANSFORMER
NEW CHAINLINK FENCE (MATCH EXISTING)
EXISTING 6'ø PRECAST CONCRETE WET WELL WITH NEW RISER & ACCESS HATCH
4"
4"
REMOVE EXISTING CHAINLINK FENCE
4"
CONNECT TO EXISTING 4" CI FORCE MAIN
NEW CHAINLINK FENCE (MATCH EXISTING)
NEW DOUBLE LEAF SWING GATE
EXISTING 10"ACP GRAVITY SEWER
FIGURE B-9
ALTERNATIVE 4 - SCHEMATIC SITE PLAN
OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER
POLLUTION CONTROL AUTHORITY
TIGHE & BOND CONSULTING ENGINEERS

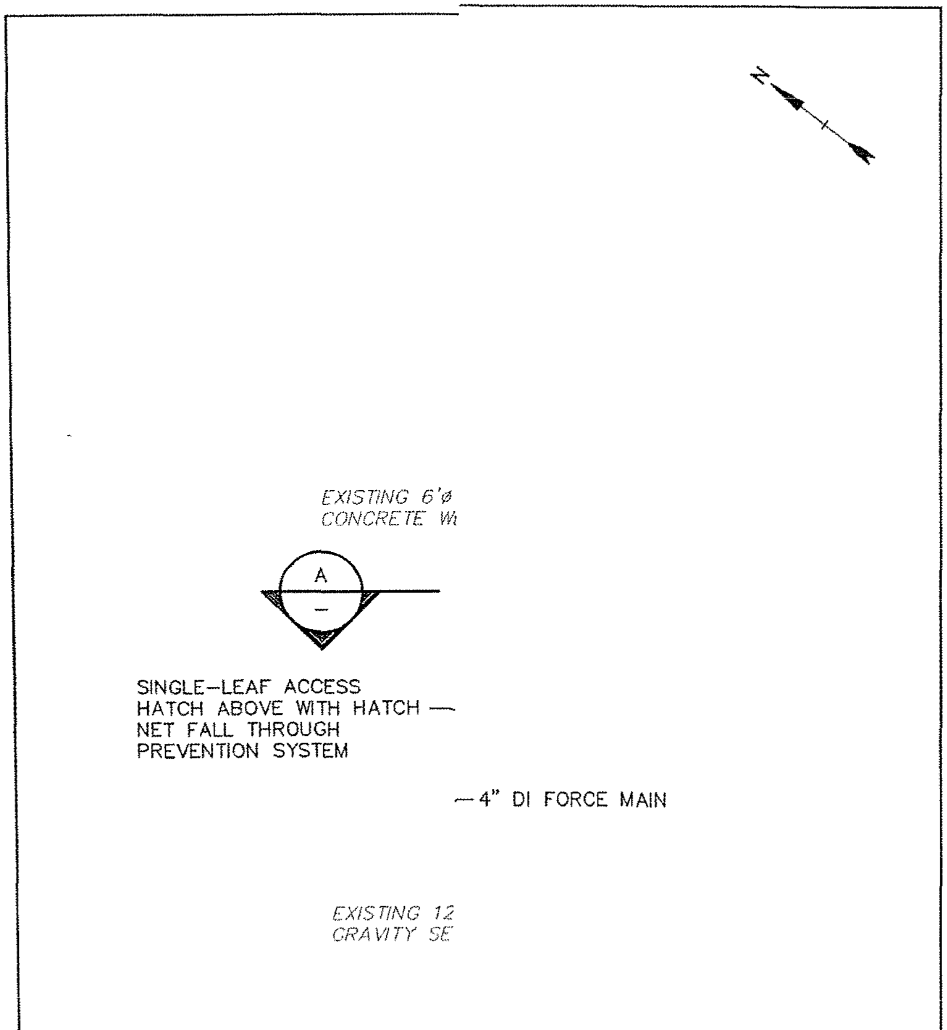


FIGURE B-10

ALTERNATIVE 4 - SCHEMATIC PUMP STATION FLOOR PLAN
OLD CHAUNCEY ROAD PUMP STATION ENGINEERING EVALUATION HAMPDEN, CONNECTICUT GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
TIGHE & BOND CONSULTING ENGINEERS WESTFIELD, MASSACHUSETTS SCALE: 1/4"=1'-0" DATE: OCTOBER 2007

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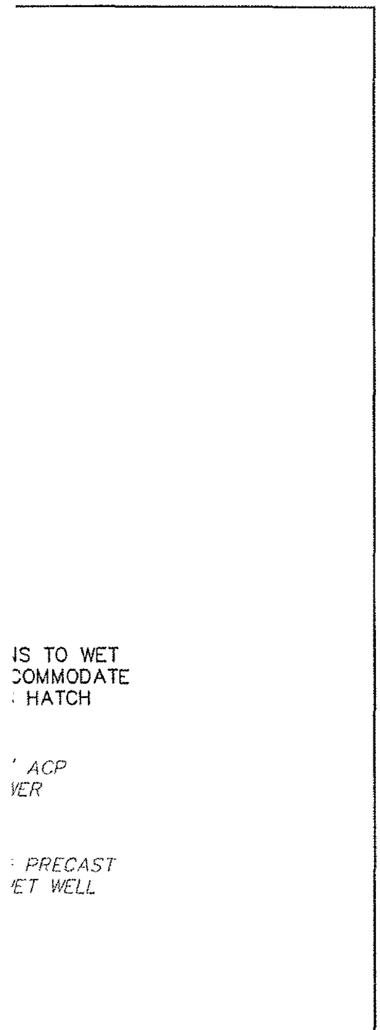

FIGURE B-11

ALTERNATIVE 4 - SCHEMATIC PUMP STATION CROSS SECTION
.D CHAUNCEY ROAD PUMP STATION ENGINEERING EVALUATION HAMPDEN, CONNECTICUT GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
TIGHE & BOND CONSULTING ENGINEERS WESTFIELD, MASSACHUSETTS :ALE: NO SCALE DATE: OCTOBER 2007

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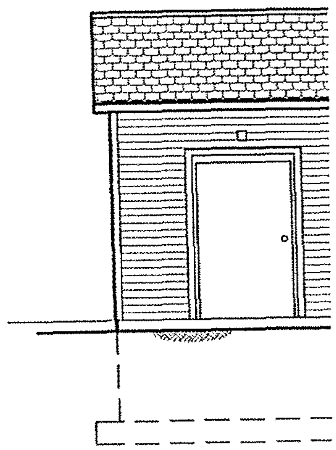
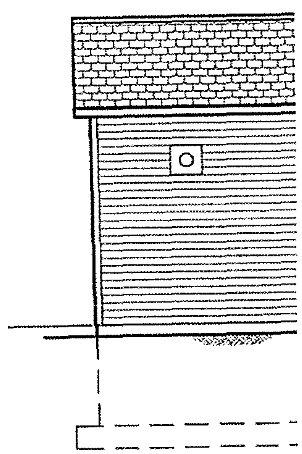


ELEVATION



ELEVATION -

FIGURE B-12

ALTERNATIVE 4 - SCHEMATIC PUMP STATION EXTERIOR ELEVATIONS

OLD CHAUNCEY ROAD PUMP STATION
ENGINEERING EVALUATION
HAMPDEN, CONNECTICUT
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY

TIGHE & BOND CONSULTING ENGINEERS
WESTFIELD, MASSACHUSETTS

SCALE: 1/8"=1'-0" DATE: OCTOBER 2007

N0606\SHT04

Table C-1
Alternative 1 (Submersible Pumping Station without Building)
Capital Costs

		Estimated Construction Cost
Division 1		
Bonds, Insurance, and General Conditions (10%)	$	35,550
Division 2		
Excavation & Backfill	$	15,000
Allowance for Contaminated Soils	$	15,000
Temporary Bypass Pumping System	$	15,000
Demolition of Drywell, Controls and Generator Enclosure	$	15,000
Drainage Improvements	$	25,000
Force Main Piping	$	7,500
Paving	$	10,000
Loam, Seed & Landscaping	$	10,000
Replace Fencing/Gate	$	15,000
Division 3		
Wetwell Top Slab	$	10,000
Valve Vault	$	10,000
Division 5		
Wetwell Hatch	$	2,500
Valve Vault Hatch	$	2,500
Wetwell Pump Guides	$	1,500
Division 9		
Interior Wetwell Coating	$	5,000
Painting	$	1,500
Division 11		
Duplex Pumping System (7.5 hp)	$	40,000
Division 13		
Magnetic Flow Meter	$	7,500
Level Control System	$	5,000
Division 14		
Davit Crane & Boot	$	5,000
Division 15		
Wetwell Piping	$	10,000
Valve Vault Piping	$	12,500
Division 16		
Conduit, Wiring, and Miscellaneous	$	15,000
Electrical Quick Disconnects & Enclosures	$	20,000
Generator and ATS	$	35,000
Outdoor Control Panel	$	15,000
PLC/SCADA	$	30,000
SUBTOTAL =	**$**	**391,050**
35% ENGINEERING AND CONTINGENCY =	**$**	**136,868**
OPINION OF PROBABLE BID PRICE =	**$**	**527,918**

Table C-1
Alternative 1 (Submersible Pumping Station without Building)
Annual Costs

						Annual O&M Costs	
2 Operators	@	$	40	per hour			
			2	hours per week			
					Labor	$	8,320
1 Pump	@	$	0.16	per kW-hr			
			7.6	hours per day			
			5.1	hp			
					Power	$	1,688
1 Pump Replacement	@		year	15			
		$	15,000	per pump			
					Annualized Pump Replacement Cost	$	667
1 Odor Control	@	$	1,000	per year			
					Odor Control	$	1,000
					TOTAL =	**$**	**11,675** per year

Table C-1
Alternative 1 (Submersible Pumping Station without Building)
Life Cycle Costs

Period (years)	20
Municipal Borrowing Rate (MBR)	5.0%
MBR A/P Factor	0.0802
Discount Rate	4.875%
Estimated Inflation Rate	3.0%
Effective Discount Rate (EDR)	1.82%
EDR A/P Factor	0.0601

Annualized Costs:	
Annual Operational and Maintenance Costs	$11,675
Annualized Capital Cost (Based on MBR)	$41,808
Total Average Annual Cost	**$53,483**

Present Worth Costs:	
EDR P/A Factor	16.6384
Annual Operational and Maintenance Costs	$194,253
Capital Cost	$527,918
Total Present Worth Cost	**$722,170**

No salvage value of improvements is assumed.

Table C-2
Alternative 2 (Submersible Pumping Station with Building)
Capital Costs

		Estimated Construction Cost
Division 1		
Bonds, Insurance, and General Conditions (10%)	$	45,830
Division 2		
Excavation & Backfill	$	25,000
Allowance for Contaminated Soils	$	15,000
Temporary Bypass Pumping System	$	15,000
Demolition of Drywell, Controls and Generator Enclosure	$	15,000
Drainage Improvements	$	25,000
Force Main Piping	$	10,000
Paving	$	15,000
Loam, Seed & Landscaping	$	10,000
Replace Fencing/Gate	$	15,000
Division 3		
Wetwell Top Slab	$	15,000
Valve Vault	$	10,000
Division 5		
Wetwell Hatch	$	2,500
Valve Vault Hatch	$	2,500
Wetwell Pump Guides	$	1,500
Division 9		
Interior Wetwell Coating	$	5,000
Painting	$	5,000
Division 11		
Duplex Pumping System (7.5 hp)	$	40,000
16' x 16' Building	$	76,800
Division 13		
Magnetic Flow Meter	$	7,500
Level Control System	$	5,000
Division 14		
Davit Crane & Boot	$	5,000
Division 15		
Wetwell Piping	$	10,000
Valve Vault Piping	$	12,500
Building Piping	$	10,000
Division 16		
Conduit, Wiring, and Miscellaneous	$	25,000
Electrical Quick Disconnects & Enclosures	$	20,000
Generator and ATS	$	30,000
PLC/SCADA	$	30,000
SUBTOTAL =	**$**	**504,130**
35% ENGINEERING AND CONTINGENCY =	**$**	**176,446**
OPINION OF PROBABLE BID PRICE =	**$**	**680,576**

Table C-2
Alternative 2 (Submersible Pumping Station with Building)
Annual Costs

					Annual O&M Costs
2 Operators	@	$	40	per hour	
			2	hours per week	
				Labor	$ 8,320
1 Pump	@	$	0.16	per kW-hr	
			7.6	hours per day	
			5.1	hp	
				Power	$ 1,688
1 Unit Heat	@		$200	per month (annual average)	
			12	Months per year	
				Heating	$ 2,400
1 Pump Replacement	@		year	15	
		$	15,000	per pump	
				Annualized Pump Replacement Cost	$ 667
1 Odor Control	@	$	1,000	per year	
				Odor Control	$ 1,000
				TOTAL =	**$ 14,075** per year

Table C-2
Alternative 2 (Submersible Pumping Station with Building)
Life Cycle Costs

Period (years)	20
Municipal Borrowing Rate (MBR)	5.0%
MBR A/P Factor	0.0802
Discount Rate	4.875%
Estimated Inflation Rate	3.0%
Effective Discount Rate (EDR)	1.82%
EDR A/P Factor	0.0601

Annualized Costs:	
Annual Operational and Maintenance Costs	$14,075
Annualized Capital Cost (Based on MBR)	$53,898
Total Average Annual Cost	**$67,973**

Present Worth Costs:	
EDR P/A Factor	16.6384
Annual Operational and Maintenance Costs	$234,185
Capital Cost	$680,576
Total Present Worth Cost	**$914,761**

No salvage value of improvements is assumed.

Table C-3
Alternative 3 (Suction Lift Pumping Station without Building)
Capital Costs

		Estimated Construction Cost
Division 1		
Bonds, Insurance, and General Conditions (10%)	$	32,400
Division 2		
Excavation & Backfill	$	10,000
Allowance for Contaminated Soils	$	15,000
Temporary Bypass Pumping System	$	15,000
Demolition of Drywell, Controls and Generator Enclosure	$	15,000
Drainage Improvements	$	25,000
Force Main Piping	$	5,000
Paving	$	10,000
Loam, Seed & Landscaping	$	7,500
Replace Fencing/Gate	$	15,000
Division 3		
Wetwell Top Slab	$	10,000
Division 5		
Wetwell Hatch	$	1,500
Division 9		
Interior Wetwell Coating	$	5,000
Division 11		
Duplex Pumping System (10 hp)	$	60,000
6' x 6' Pump Enclosure	$	15,000
Division 13		
Magnetic Flow Meter	$	7,500
Level Control System	$	5,000
Division 15		
Wetwell Piping	$	7,500
Division 16		
Conduit, Wiring, and Miscellaneous	$	15,000
Generator and ATS	$	35,000
Outdoor Control Panel	$	15,000
PLC/SCADA	$	30,000
SUBTOTAL =	**$**	**356,400**
35% ENGINEERING AND CONTINGENCY =	**$**	**124,740**
OPINION OF PROBABLE BID PRICE =	**$**	**481,140**

Table C-3
Alternative 3 (Suction Lift Pumping Station without Building)
Annual Costs

						Annual O&M Costs
2 Operators	@	$	40	per hour		
			3	hours per week		
				Labor	$	12,480
1 Pump	@	$	0.16	per kW-hr		
			7.6	hours per day		
			7.6	hp		
				Power	$	2,515
1 Unit Heat	@		$150	per month (annual average)		
			12	months per year		
				Heating Cost	$	1,800
1 Pump Replacement	@		year	20		
		$	20,000	per pump		
				Annualized Pump Replacement Cost	$	750
1 Odor Control	@	$	1,000	per year		
				Odor Control	$	1,000
				TOTAL =	**$**	**18,545** per year

Table C-3
Alternative 3 (Suction Lift Pumping Station without Building)
Life Cycle Costs

Period (years)	20
Municipal Borrowing Rate (MBR)	5.0%
MBR A/P Factor	0.0802
Discount Rate	4.875%
Estimated Inflation Rate	3.0%
Effective Discount Rate (EDR)	1.82%
EDR A/P Factor	0.0601

Annualized Costs:	
Annual Operational and Maintenance Costs	$18,545
Annualized Capital Cost (Based on MBR)	$38,104
Total Average Annual Cost	**$56,649**

Present Worth Costs:	
EDR P/A Factor	16.6384
Annual Operational and Maintenance Costs	$308,566
Capital Cost	$481,140
Total Present Worth Cost	**$789,706**

No salvage value of improvements is assumed.

Table C-4
Alternative 4 (Suction Lift Pumping Station with Building)
Capital Costs

		Estimated Construction Cost
Division 1		
Bonds, Insurance, and General Conditions (10%)	$	49,340
Division 2		
Excavation & Backfill	$	30,000
Allowance for Contaminated Soils	$	15,000
Temporary Bypass Pumping System	$	15,000
Demolition of Drywell, Controls and Generator Enclosure	$	15,000
Drainage Improvements	$	25,000
Force Main Piping	$	7,500
Paving	$	15,000
Loam, Seed & Landscaping	$	7,500
Replace Fencing/Gate	$	15,000
Division 3		
Wetwell Top Slab	$	10,000
Division 5		
Wetwell Hatch	$	1,500
Division 9		
Interior Wetwell Coating	$	5,000
Painting	$	7,500
Division 11		
Duplex Pumping System (10 hp)	$	60,000
16' x 28' Building	$	134,400
Division 13		
Magnetic Flow Meter	$	7,500
Level Control System	$	5,000
Division 14		
Monorail Pump Lifting System	$	10,000
Division 15		
Wetwell Piping	$	7,500
Building Piping	$	10,000
Division 16		
Conduit, Wiring, and Miscellaneous	$	30,000
Generator and ATS	$	30,000
PLC/SCADA	$	30,000
SUBTOTAL =	**$**	**542,740**
35% ENGINEERING AND CONTINGENCY =	**$**	**189,959**
OPINION OF PROBABLE BID PRICE =	**$**	**732,699**

Table C-4
Alternative 4 (Suction Lift Pumping Station without Building)
Annual Costs

						Annual O&M Costs
2 Operators	@	$	40	per hour		
			3	hours per week		
				Labor	$	12,480
1 Pump	@	$	0.16	per kW-hr		
			7.6	hours per day		
			7.6	hp		
				Power	$	2,515
1 Unit Heat	@		$250	per month (annual average)		
			12	months per year		
				Heating	$	3,000
1 Pump Replacement	@		year	15		
		$	20,000	per pump		
				Annualized Pump Replacement Cost	$	667
1 Odor Control	@	$	1,000	per year		
				Odor Control	$	1,000
				TOTAL =	**$**	**19,662** per year

Table C-4
Alternative 4 (Suction Lift Pumping Station without Building)
Life Cycle Costs

Period (years)	20
Municipal Borrowing Rate (MBR)	5.0%
MBR A/P Factor	0.0802
Discount Rate	4.875%
Estimated Inflation Rate	3.0%
Effective Discount Rate (EDR)	1.82%
EDR A/P Factor	0.0601

Annualized Costs:	
Annual Operational and Maintenance Costs	$19,662
Annualized Capital Cost (Based on MBR)	$58,026
Total Average Annual Cost	**$77,688**

Present Worth Costs:	
EDR P/A Factor	16.6384
Annual Operational and Maintenance Costs	$327,151
Capital Cost	$732,699
Total Present Worth Cost	**$1,059,850**

No salvage value of improvements is assumed.